DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The following description is provided to enable any person skilled in the art to make and use the invention and sets forth the best modes contemplated by the inventors of carrying out their invention. Various modifications, however, will remain readily apparent to those skilled in the aerospace art, since the general principles of the present invention have been defined herein specifically to provide an improved panel spacer and method and apparatus of installing the same, for example in a floor panel of an aircraft.

A spacer of the present invention is disclosed in Figure 1. The spacers of the present invention can be broadly described as inclusive of panel inserts that are to be mounted in a sandwich panel structure where an upper edge of a rim is deformed to provide an edge which is flush with the perimeter of the hole. The spacer can have a smooth central bore whereby a fastener will extend through the bore for mounting with a nut or clip nut. Alternatively, the spacer can have a threaded bore to permit a direct fastening with a screw or can capture a floating nut for connection with a bolt. As can be appreciated, various forms of spacers and inserts can generically enjoy the advantages of the present invention and accordingly the present invention should not be limited to the preferred embodiments set forth herein.

As can be appreciated, the height of the spacer can vary depending upon the particular thickness of a sandwich panel structure. Thus, the body of spacer 2 of the present invention has a height L so that when its lower flange 4 is adhered to the lower surface of a sandwich panel structure, the upper rim 6 will have a height R that has been designed in combination with its thickness to be cold-worked or deformed by an applicator setting tool of a particular configuration to permit the upper portion of the entrance rim to be driven into the sandwich panel structure to lie flush with the upper

panel surface and to bulge slightly outward beneath the face plate of the panel to assist in locking the spacer into the panel structure. The entrance rim 6 can further have a beveled upper outer edge 8 of a thickness T. Various modifications of the rim configuration can be provided to encourage both a locking deformation and to facilitate a seal with the panel structure, and accordingly, the embodiments disclosed herein should not be considered as limiting the scope of the present invention.

A central aperture 10 has a diameter substantially less than both the inner diameter B and the outer diameter A of the rim 6. A conical tapered entrance 12 to the central aperture 10 extends from the lower interior of the rim 6.

The spacer 2 can be formed of a material that is compatible with its corresponding panel and which has the capacity to permit deformation of the rim 6 to lie flush with the surface of a panel structure and to assist in locking the rim to the panel structure. For example, an aluminum alloy 6061 T-6 could be machined to create the spacer 2. Other material can be titanium, stainless steel or other metals that can be formed, for example by cold working.

As an example of dimensions for a sandwich panel of 0.400 inches in thickness, the diameter W of the lower flange can be 0.875 inches, the outer diameter A of the body 14 can be 0.435 inches, the height of the spacer L can be 0.455 inches, while the thickness of the flange 4 can be 0.020 inches. The height of the rim R can be approximately 0.070 inches, while the height of the beveled upper edge 8 could be approximately 0.035 inches.

Figure 2 discloses an illustration of a typical panel sandwich structure 16 wherein a drill 18, such as a diamond bit drill, can provide a hole or bore in a panel to be used as a floor in an aircraft. Generally, the bottom surface of the panel is supported

during the drilling procedure, for example, by a block of wood. A numerically controlled drilling machine can automatically provide the desired number of holes in a panel. A numerically controlled drilling machine can automatically provide the desired number of holes in a panel. The panel 16 has an upper planar face sheet of aluminum or laminated resin plate 20 and a lower planar face sheet of aluminum or laminated resin plate 22. These face sheets can sandwich a honeycomb core structure 24 of cells that can be formed, for example, of a resin impregnated paper or thin strips of expanded aluminum foil. The honeycomb core 24 forms a low density structure and comprises hexagonical cells with walls perpendicular to the face sheets. A wide variety of materials can be used in the construction of the sandwich core, including high temperature alloys of paper, wood, foam, and plastic syntactic, along with steel. Typical application of sandwich panel structures in the aircraft industry are floor and ceiling panels, interior panels, baggage overhead racks, and galleys. Also the panels are sometimes used for instrumentation enclosure, shelves, and bulkhead panels.

While the present invention is particularly adapted for installation in composite and sandwich panels where a core structure has a different density than a face sheet and the spacer can both seal and be deformed to extend beneath the face sheet, it is also contemplated that a solid panel could receive the spacer of the present invention with an interference fit.

The nature of the sandwich panel structure material is such that it can only carry a limited concentrated loading due to its breakable face skins. Selecting a method for transmitting loads into and out of the panel is important in a successful utilization of a sandwich structure, therefore a large number of spacers are frequently used to distribute the total load when fasteners are attached, for example to a bulkhead in an aircraft.